REVIEW ARTICLE

Effect of Brahmi Swarna Yoga on neurocognitive functions in autistic children: A review

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Abstract

Autism is a developmental disorder due to some disruption in neuronal connectivity. In some such cases show genetic back ground and some studies in animal models and studies of individuals with autism spectrum disorder (ASD) indicate changes in brain volume and neural cell density in the limbic system, cerebellum, frontotemporal regions one study documented hyper expansion of cortical surface area, which correlated with later development of impaired social skills. Some studies are proven that cognitive ability can have an impact on social skill development in ASD. The ingredients of the drug *Brahmi Swarna Yoga* are scientifically proven for its cognitive and memory enhancement action.

Key words: Autism, brahmi, cognition, ghrita, memory, sankhapushpi, swarna bhasma

INTRODUCTION

Autism is a neuro biological disorder onset in early childhood. The prevalence of autism spectrum disorders (ASDs) is estimated 1 in 59 persons by the US centers for disease control and prevention and also there is significant increase in autism prevalence in past 25 years. It is characterized by problems in social -emotional reciprocity, non-verbal communication, and understanding of social relationship. Etiology of autism is not clear, and it may result from disrupted neural connectivity and is primarily impacted by genetic variations affecting early brain development.[1] According to Ayurvedic wisdom autism has to understood in metaphysical that and biological level. Autism is a condition that affects social communication and blocks sensory transmission. However, it is unclear what causes this social skill deficit, and prior research has indicated that cognitive ability can have an impact on social skill development in ASD. As a result, worse social skills are linked to decreased cognitive performance.[2] Patients with ASD have reduced self-monitoring abilities and response initiation. Mentalizing and self-awareness require some executive function. There is a substantial correlation between social cognition, planning, and metacognitive functions like executive function. Impairment in executive function may be a contributing factor to repeated behaviors, one of the basic symptoms of ASD. The prefrontal cortex, an area involved in executive function, is one of the brain regions implicated in social cognition. Significant difficulty in interpreting mental states is present in autism.[3] Mainly Autism can be understood in two ways, one is biological, in which the problem is related to *koshta (*GI disorders, Gut dysbiosis) or *dhatu* derangement of metabolism and production of neurotoxins) and the other one is at the level of the *atma, manas,* and *budhi*. There is *apakva parinam* both in the koshta and *dhatu* levels and there is production of *ama* in both levels and improper *rasadhatu* is formed. When we consider another level, the knowledge or *gyana* is attained by proper association of *indriya, indriyartha, manas,* and *atma.* Any derangement in this process leads to an absence of knowledge, so the patient cannot respond to social stimuli, which leads to behavioral disorders.[3] This same thing occurs in autism. The pathophysiology of disease *unmada* bears resemblance to that of autism, in both there is derangement in *manas, budhi, samja, jana, smriti*, and *bhakti*. That it can understood along the lines of *unmada* in a lesser degree and can be categorized as a minor psychological developmental disorder affecting the child. When the symptoms exist in

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a minor form it could be considered autistic behavior. The available information shows that the prevalence of ASDs is increasing day by day. To date, no preventive strategies have demonstrated consistent benefits and no treatments have proven widely efficacious in treating the core symptoms of ASD. Lack of specific therapies or medication to manage autism puts a challenge in front of pediatrician to manage such patients. And the available therapies like, behavioral intervention, are the mainstay of treatment for core deficits in ASD. FDA approved medications for ASD are the atypical antipsychotics Risperidone and Aripiprazole. Both are approved for the treatment of irritability, defined by physical aggression and tantrum behavior. Their primary, sometimes dose-limiting side effects include weight gain and sedation.[4] It is clear from this that people with autism require medications that affect brain function, particularly memory and cognitive power.

MATERIALS AND METHODS

This review is in a narrative format and consists of all publications relevant to autism, cognition enhancing properties of *Bhrami, Sankhapushpi*, *Swarna bhasma*, ghee, and honey that were identified by the authors through a systematic search of major computerized medical databases; no statistical pooling of results or evaluation of the quality of the studies were performed due to the widely different methods employed by each study.

RESULTS

Subject related articles are searched from different databases PubMed = 30 Google scholar =, 102, Evidence-Based Complementary and Alternative Medicine = 2, journal of Ayurveda and integrated medical sciences = 0.2 Indian Journal of Pharmacology = 2 After identifying repeated articles, the final list of articles reviewed were 94.

Effect of *Brahmi Swarna Yoga* in Improvement in Cognition

Swarna prasa is a Herbo-mineral compound mentioned by different acharyas and commonly used in pediatric communities. In ancient community it was prepared as follows, raw gold is smeared on a stone with water while reciting mantras and offered along with *madhu* and *ghrita* in newborn. That's is shortly after birth, hence it is considered as *jatamatra samskara. Swarnaprasa* has many beneficial effects it enhances *medha, agni, bala, ayu, varnya*, it is considered as *pavitra, mangalakara*, and *vrishya*. If given for 1 month, the child became *medhavi*, and if given for 6-month child became *shrutadhara.* This concept implies that *swarnaprasa* has a remarkable role in improving memory and that its use also imparts significant improvements in cognitive function. Acharya Sustra mentioned in *sareerasthana,* different,combinations while making *swarnaprasa* as *jatakarma samsaskara*. *Ghrita* is a substance that has properties such as *dhee, smriti, medha,*

Memory Enhancing and Cognitive Properties of Brahmi

Researcher/author	Tested in	Outcomes
Yadav *et al*.[5]	*Brahmi ghrita* administered orally at the dose 400 and 800 mg/kg respectively	• *Brahmighrita* and piracetam treated rats demonstrated a significant decrease in transfer latency in modified elevated plus maze test • Prolonged use of *Brahmi* leads to elevation of cerebral glutamic acid and transient increase in gamma aminobutaric acid, which may be helpful in the process of learning
Singh and Dharwan[6]	Alcoholic extract of *brahmi* (40 mg/kg, *P* o. × 3d) in albino rats	It is observed that *Brahmi* improves motor learning, acquisition and retention, and delay extinction of newly acquired behavior
Vollala *et al*.[7]	Different doses of BM extract administered orally for different periods of time in 10 days old neonatal rat pups	The results showed improvement in spatial learning performance and enhanced memory retention in neonatal rats treated with extract of BM as compared with those in control group
Vollala *et al*.[8]	*Bacopa monnieri* extract is administered in 2½-month-old Wistar rats, in 3 groups (each group contain 8 number) as divided doses 20 mg/kg, 40 mg/kg and 80 mg/kg for a period of 2, 4, 6, weeks. further after decapitation brains of rats were removed and observed amygdaloid neurons	• Results showed an improvement in spatial learning performance and enhanced memory retention in rats treated with *Bacopa monnieri* extract • Significant increase in dendritic length and the number of dendritic branching points is obtained in rat treated with *brahmi* extract for 4 and 6 weeks. • *Bacopa monnieri* extract have neuronal dendritic growth-stimulating properties.

Memory Enhancing and Cognitive Properties of Brahmi		
Researcher/author	**Tested in**	**Outcomes**
Ramasamy *et al*.[9]	*In silico* and *in vitro* studies of parent compounds (bacosides), aglycones and their derivatives (ebelin lactone and bacogenin A) and compounds were screened *in vitro* using radioligand receptor binding and AChE inhibition assays	• Parent bacoside have poor molecular property as CNS drug. • Aglycones and their derivatives showed better binding affinity and good CNS drug-like properties, these were well absorbed through the intestines and had good BBB penetration. • These are the main bioactive constituents responsible for the cognitive effects of *B. monnieri*
Le *et al*.[10]	Alcoholic extract of *Bacopa monnieri* (50 mg/kg for 1 week before and 3 days after OBX) tested on olfactory bulbectomized (OBX) mice.	Mice treated with *Bacopa monnieri* extract showed improvement in OBX-induced cognition dysfunction
Pham *et al*.[11]	*Bacopa monnieri* (L.) WETTST. extract (BME) administered in trimethyltin induced neurotoxicity mice model	Result showed that BME administration significantly prevented TMT induced cognitive deficits. Also showed protective effect on spatial memory deficits. via protecting the hippocampal neurons and partly via promoting neuro regeneration in the dentate gyrus regions.
Ong *et al*.[12]	*Bacopa monnieri* supplement is given to f non-sleep-deprived (slp+) and sleep-deprived (slp−) fruit flies (Drosophila melanogaster)	Result showed that *Bacopa monnieri* supplementation enhances both the learning capacities and the short-term memory retention of both non-sleep-deprived and sleep deprived fruit flies.
Varshney *et al*.[13]	Experimental study conducted on Wistar albino rats over a period of 20 days. Rats were divided into five groups of five animals each group given with Group I- consisted of animals which were given 1% Gum acacia, Group II- Scopolamine (1 mg/kg body wt.), Group III- Metformin (100 mg/kg body wt.), Group IV- *Bacopa monnieri* (100 mg/kg body wt.), Group V Rivastigmine (0.5 mg/kg body wt.)	The results from this study have shown that Metformin and Bacopa have markedly improved learning and memory in rats as compared to Scopolamine group.
Kamkaew *et al*.[14]	Randomized double blind placebo control trial conducted in elderly group aged between 50 and 80. Extract of *Bacopa monneri* leaves along with mulberry juice.	• Response latency was reduced by 14.2±4.9% (P=0.022 comparing placebo) • No change was detected in carotid blood velocity while microvascular blood flow marginally increased (by 28.4±8.3%, P=0.07). • Found that increased working memory
Rai *et al*.[15]	Extract of *Bacopa monneri* (CDRI-08) administered to scopolamine-treated amnesic mice	Amnesic mice restored the spatial memory. And there is significant upregulation of the GluN2B subunit expression and decline in the acetylcholinesterase activity in prefrontal cortex as well as hippocampus
Anamika and Muralidharan[16]	Hydroalcoholic extract of *Bacopa monnieri* was administered orally using nasogastric tube in autistic rat models. To find propionic acid-induced neuroprotective effect	• This research showed that *Bacopa monnieri* protected against intracerebroventricular PPA infusion from the biochemical, behavioral, and physiological perspectives • Also showed considerable neuroprotective and anti-inflammatory properties and memory enhancement
Saini *et al*.[17]	BM extract was administered orally (50 mg/kg body weight, daily) for 15 days in colchicine administered male Wistar rats	Result showed that *Bacopa monneri* administration is able to improve cognitive functions by suppressing beta amyloid formation that is through its anti-inflammatory and antioxidant action.

Memory Enhancing and Cognitive Properties of Brahmi		
Researcher/author	**Tested in**	**Outcomes**
Roodenrys *et al*.[18]	Arandomized, placebo control study, conducted in 75 adults aged between 40 and 65. They were divided into two groups and administered *brahmi* capsule in one group and placebo in another group	Result showed significant effect on retention power of new information rate of learning is unaffected, and improvement in attention, verbal and visual short-term memory
Kwon *et al*.[19]	*Bacopa monnieri* extract is administered on 7-week-old mice once a day for 4 weeks.	• BM treated mice showed moderate increases in the exploration of new objects when compared with that of familiar objects, leading to a significant higher discrimination index compared with vehicle-treated mice • The administration of BME promoted novel object recognition, and increased cell proliferation and neuroblast differentiation as well as upregulation of BDNF protein expression and CREB phosphorylation.
Ph *et al*.[20]	• Alcoholic extract of *Bacopa monneri* were administered in olfactory bulbectomized (OBX) mice • *Ex vivo* and *in vitro* studies done after decapitation.	*Bacopa monneri* extract administration improved cognitive function through enhancement of synaptic plasticity-related neuronal signaling and BDNF transcription.
Rani and Prasad[21]	A standardized extract of *Bacopa monnieri* (CDRI-08) (200 mg/Kg BW) were administered in CoCl2-induced hypoxic Male Swiss albino mice of age 20±5 weeks.	• Result showed that, CDRI-08 administration reverses the memory loss • This study also reveals that CDRI-08 upregulates FMRP expression and it is likely to possess the neuroprotective or restorative effects.
Sudhakar *et al*.[22]	Standardized aqueous ethanolic extract of *Bacopa monneri* (BacoLive) is administered in amnesic Swiss albino mice (Scopolamine induced memory loss) and compared with control groups.	Present study demonstrated effectiveness of bacoliv in learning and memory enhancing effects and also reversed cognitive deficits induced by scopolamine.
Dethe *et al*.[23]	Standardized *Bacopa monneri* extract (BacoMind) screened *in vitro* in a panel of cell-free and receptor-transfected cell assays.	At least five separate molecular targets of memory are impacted by BM, which then affects cholinergic, dopaminergic, and serotonergic pathways. The cumulative effects of BM on various enzyme and receptor-based targets can be connected to its memory-improving benefits.
Nui *et al*.[24]	A randomized double-blind placebo-controlled trial consisting of 23 males and 37 females, were administered extract of *B. monnieri* (300 and 600 mg) in one group and other group with placebo.	Working memory was improved in the *Bacopamonnieri,* treated group, and N100 and P300 latencies were reduced as well. Additionally, the plasma AChE activity was shown to be suppressed. These findings imply that *B. monnieri* can enhance working memory, cognition, and attention.
Uabundit *et al*.[25]	Alcoholic extract of *Bacopa monnieri* is orally administered Male Wistar rats via feeding needle for a period of 2 weeks.	• *Bacopa monnieri* extract improved the escape latency time • It has potential cognitive enhancing effect and also have neuroprotective effect
Calabrese *et al*.[26]	A randomized double blind placebo control trial consisting of 55 participants with 65 year or older were divided into two groups and given *Bacopa monneri* extract in one group and placebo in another group	Found that *Bacopa monneri* extract safely enhanced cognitive power

Memory Enhancing and Cognitive Properties of Brahmi		
Researcher/author	**Tested in**	**Outcomes**
McPhee *et al*.[27]	This was a randomized, double-blind and placebo-controlled trial on 28 healthy adults aged over 55 years. Participants were received either BM or placebo, after complete CT 3 h weekly for 12 weeks.	Results showed slower response times in the BM group in an image discrimination task and faster reaction times in the placebo group in a spatial working memory task. BM group results may point to an increase in network complexity (through higher dendritic branching)

BBB: Blood–brain barrier, CT: Cognitive training

Memory Enhancing and Cognitive Properties of *Sankhpushpi*		
Researcher/author	**Tested in**	**Outcomes**
Bihaqi *et al*.[28]	AE *Convolvulus pluricaulis* was given in male Wistar rats who have administered scopolamine	• It was discovered that a dose of 150 mg/kg given orally for 7 days reduced the impairment of learning and memory caused by scopolamine in rats. • By the action of AE acetylcholine activity is decreased it leads to learning and memory improvement in rats.
Amin *et al*.[29]	30 volunteers who have complaint memory loss were selected for this study. They are given with *sankhapushpi* tablet of 500 mg for 2 months. pre and post analysis done by WMS	*Śaṅkhapuṣpī* tablet shown highly significant results in improving memory, especially in long term memory loss in younger age group.
Amin *et al*.[30]	Randomized control trial conducted on healthy volunteers divided in two group in which trial group (50 individual) given *Satvavajaya Cikitsa*, which include Yogic procedures, placebo and counseling for motivation. Group B (52 volunteers) who received four *Shankhapushpi* tablets (500 mg)	While *Shankhapushpi* fared far better in the improvement of long-term memory, *Satvavajaya Chikitsa* exhibits exceptional improvement in quick remembering. Since both treatments improved volunteers' levels of self-esteem, attention, and concentration, improving their academic and professional performances,
Tiwari *et al*.[31]	Aqueous extract of *sankhapushpi* is administered in Wistar albino rats	• Result showed that significant effect of *sankhapushpi* extract on memory enhancement.
Malik *et al*.[32]	Aqueous methanol extract of Convolvulus *pluricaulis* on Laca mice	Result showed thatshowed maximum memory-enhancing and anxiolytic activity showed maximum nootropic activity.
Sharma *et al*.[33]	Ethanolic extract of *Convolvulus pluricaulis*, asparagus racemose, distilled water, and piracetam was given in different groups of mice and compared with the group pretrial group	Enhancement of memory is observed in the group treated with *C. pluricaulis* and *A. racemosa* and also observed that the retention power more prominent in the group treated with *C. pluricaulis*
Sethiya *et al*.[34]	Methanol extract of *convolvulus pluricaulis* is administered in, scopolamine treated mice models and *in vivo* studies are also conducted	• Result showed anti-amnesic effects of *Shankhpushpi* on scopolamine induced amnesia. Also observed memory enhancing effects • Methanol extracts of *Shankhpushpi* produced better retention and recovery.
Bihaqi *et al*.[35]	Oral administration of *Convolvulus pluricaulis* in aluminum chloride induced neurotoxicity rat model	The result showed that oral administration of cppreserved the mRNA levels of muscarinic receptor 1 (M1 receptor), ChAT and NGF-TrkA.
Shukla *et al*.[36]	Ayurvedic polyherbal plant extracts (AG, GG and CP) is administered in scopolamine-induced memory impairment rat models. biochemical estimation is also performed.	• Result showed that marked improvement in scopolamine induced memory loss. • Biochemical parameters exhibited a reduction in MDA and AChE levels with an increase in GSH level after treatment with extracts and PHF • PHF is an effective formulation for learning and memory processes against scopolamine-induced memory impairment.

WMS: Weschler's memory scale, ChAT: Choline acetyl transferase, NGF-TrkA: Nerve growth factor-tyrosine kinase A receptor, AG*:* Alpinia *galangal*, GG: *Glycyrrhiza glabra*, CP*: Convolvulus pluricaulis*, AE: Aqueous extract

Effect of Ghee or Fatty Acids on Cognition and Brain Function		
Researcher/author	**Tested in**	**Outcomes**
Yehuda *et al*.[37]	15 independent groups of rats (*n*=12) which were administered with either saline, mineral oil (vehicle) or SR-3 (25 mg/kg, a 1:4 mixture of a-linolenic and linoleic acid) for 0, 1, 2, 3, or 4 weeks.	Significant changes in the composition of the neuronal membrane were brought about by SR-3, including an improvement in learning performance and an increase in the levels of essential and total fatty acids.
Dufoura *et al*.[38]	Rats are divided into two groups and one is administered with regular diet and other with regular diet. And compared with control group.	• The result showed that cholesterol-rich diet affects learning speed and performance • CD rats displayed an increase in paired-pulse ratio in both glutamatergic synapses (+48±9%) and GABAergic synapses (+41±8%), suggesting that the CD induces long-lasting changes in presynaptic function.
Pandey and Pawar[39]	*Panchagavya ghrta* (PGG) is administered in Diazepam induced amnesia rat models. In different doses.	PGG reversed successfully the amnesia induced by Diazepam and also it shows significant memory enhancement action in MWM test (Morri's water maze).

Effect of Swarna on Memory or Cognition		
Researcher/author	**Tested in**	**Outcomes**
Abraham *et al*.[40]	Aqueous dispersion of colloidal metallic gold, with a concentration of 30 mg per ounce of fluid is administered in 5 subjects of age ranging from 15 to 45 years for 4 weeks. And assessed with revised WAIS-R both before and after.	Observed a significant increase (20%) of the mean IQ scores. And the effect is persisted 2 months after the trial. Both verbal (non-learning and performance (learning) is improved.
Muller *et al*.[41]	Injection of GNPs was given in sporadic AD model of rats, generated by intracerebroventricular-streptozotocin (i.c.v.-STZ) injection	GNP treatment prevented these pathological events in the brain, (mitochondrial function, increasing the oxidative stress and inflammatory factors) which cause impairment in memory (Spatial and recognition memory in a rat AD model)
Tramontin *et al*.[42]	OA injected Alzheimer's disease model rats treated with treated with gold nanoparticle (20-nm AuNP, at a dose 2.5 mg/kg) every 48 h for 21 days.	• AuNP treatment prevented the neuroinflammation, modulation of mitochondrial function • Restore the cognition function induced in AD model
Shah *et al*.[43]	Two gold preparations (Ayurvedic *Swarna Bhasma* and Unani *KushtaTila* Kalan) were administered in stress rat models. And assessment was done different time points of 1 h, 2 h and 4 h. Brain catecholamine, serotonin and plasma corticosterone levels were determined following 1, 2, and 4 h restraint stress.	The results showed significant restoration of altered values to near normal levels and it suggest effect of for gold preparations in stress and depression.
Bhaskaran *et al*.[44]	Scopolamine induced amnesia in albino mice were grouped into three and administered with trial drug (contained *Swarna Bhasma*, honey and ghee) adjuvant drug (contained only ghee and honey) in another group, other group was kept as the normal control.	• The result obtained showed thatSignificant reduction of transfer latency in trial drug treated group. due to inhibition of breakdown of Acetylcholine (most important neurotransmitter involved in the regulation of cognitive functions.) • *Swarna Bhasma* exhibited remarkable therapeutic effects on memory and learning in albino mice.

Effect of Swarna on Memory or Cognition		
Researcher/author	**Tested in**	**Outcomes**
Khan *et al*.[45]	Sleep deprived male albino rats were administered with *swarnabhasma* and compared with normal group sleep deprived control, galantamine groups. The cognitive performances were checked on the 7th, 14th, and 20th days.	• The result found that there is reversal of sleep deprivation induced cognitive impairment in *swarnabhasma* treated group • Also showed improved spatial memory, increased accurate arm entries, decreased the frequency of errors, and decreased transfer latency.

WAIS-R: Wechsler intelligence scales battery of tests, GNPs: Gold nanoparticles, OA: Okadaic acid, AD: Alzheimer's disease

and agni vardhana along with *samskarasya anuvarthanana*. Instead of normal *ghrita, ghrita* prepared with *medhya* drugs such as *brahmi* and *sankhapushpi* is used and prepared in a similar manner to that used in *swarnaprasana. Brahmi*, sankhapushpi, and *swarna bhasma* are the drugs mentioned in different Ayurvedic samhitas as intellect promoting and memory enhancing and *rasayana* drugs.

DISCUSSION

Bhrami Swarna yoga is a herbomineral compound containing *Brahmi, sankhapushpi ghrita*, honey, and gold particle. Most of the ingredients in this compound is known for their memory enhancing effects. Brahmi is described as a "*Medhya*" drug (the drug that possesses properties that support memory, re-establish intellectual deficiencies, and enhance mental capacity).[46] It has various medicinal properties, such as an anti-inflammatory, analgesic, antipyretic, sedative, antiepileptic, antioxidant, immuno-modulatory, memory enhancing, anti-stress, anti-anxiety, and anti-cancer.[47-50] The chemical constituents of *Bacopa monnieri* are alkaloids, brahmine, and herpestine.The major phytochemicals reported are saponins, terpenoids[51] monnierin, hersaponin, tannins, flavonoids,[52] and glycosides.[53] Bacosides A and B. Saponins are classified as pseudojujubogenin and jujubogenin glycosides and are reported as an important part of the plant. Among these Bacosides A and B have been known for memory-enhancing properties. Bacoside A also possesses nitric oxide which permits the lightening of the aorta and veins in order to enhance the blood flow more freely throughout the body, making this significant plant a nootropic drug.[54] Ayurvedic properties are *Vatahara*: Calms *vata* (maintains the circulatory system) *Anuloma*: Redirects the flow of *vata* (blood flow) downwards *Unmadahara*: Helps to reduces mental illness, *Pradnya shakti*: Increases intellectual power, *Hridya*: Heart tonic, *Majjadhatu rasayana*: Rejuvenative, particularly used to treat nervous system disorders. *Ayushya vardhana*: extends life *Balyam*: Gives, strength, (especially to the mind*) Jeevaniya*: Promotes energy, Medhya -Nervine, *Nidrajnana*: Promotes sleep *Kushtaghna* -Alleviate skin conditions.[55,56] Hence the above-mentioned studies showed that *brahmi* is a drug useful in treating neurocognitive deficits and helpful in memory enhancement. *Sankhapushpi* is the drug mentioned under *medhya rasayana* by acharya charaka, it is considered a brain tonic and many studies have proven that the isolated metabolites and crude extract have exhibited a wide range of *in vitro* and *in vivo* pharmacological effects, including CNS depression, anxiolytic, tranquillizing, antidepressant, antistress, neurodegenerative, ant amnesic, antioxidant, hypolipidemic, immunomodulatory, analgesic, antifungal, antibacterial, antidiabetic, antiulcer, anticatatonic, and cardiovascular activity.[57] Scopolamine exhibited antioxidant effects and also regulated tumor necrosis factor-a and prostaglandin E2PGE2) levels.[58] *C. pluricaulis* also possesses hypotensive, anti-anxiety and hepatoprotective properties and is also used to treat hypertension.[59-61] *C. pluricaulis* has been found to be used as a nerve tonic, and it also augments both memory enhancement and cognitive effects, as observed in numerous behavioral studies.[62,63] It has been long recognized that oxidative stress may cause neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease and also induce apoptosis. It contains chemical compounds such as bioactive components such as cinnamic acid, pentatonic acid, ascorbic acid, Vitamin E, phthalic acid, squalene, silane, decanoic acid, linoleic acid, b-sitosterol, tropane alkaloids, and kaempferol.[35] It has Ayurvedic properties such as *Nadi balya* (nervine tonic), *Swarya* (good for voice), *Rasayana* (Rejuvinating), *Varnya* (improving complexion) and is commonly used in diseases such as *Anidra* (insomnia), *Bhrama* (Vertigo), *Unmada* (Psychosis), and *Apasmara* (Seizure disorder). Based on the above properties and clinical research it is proven that it is a good nervine tonic and can be used to treat memory impairment and other cognitive deficits. Here, *ghrita* is considered as good drug for crossing the blood brain barrier because it provides a lipid medium for other *medhya* drugs. It suggests that drugs are more bioavailable in lipid (ghee) media. Some studies show that drugs in *ghrita* form are more readily absorbed.[64] It contains beta-carotene and Vitamin E, which are antioxidants themselves. Bioactive compounds present in ghee fatty acids, phospholipids and fat-soluble vitamins (Vitamins A, D, E, and K) hydrocarbons, carotenoids, sterols, sterol esters, casein, copper, and traces of iron phosphorus, Copper, and β carotene these are responsible for the therapeutic action of ghee. There are many proven pharmacological activities present in ghee such as immunostimulant activity, antioxidants, memory enhancing activity, antimicrobial, antiseptic, antibacterial, antifungal, anticancer, antidiabetic, hepato-protective,

anticonvulsant, antistress, analgesic, anti-hemorrhoids, eye lubricant, anticollestric activity, promotes wound healing radioactive radiation protection, and anti-viral property.[65-68] It contains 8% lower saturated fatty acids which make it easily digestible, cholesterol and saturated fatty acid they are main components of the cell membrane and they provide stiffness to the cell wall and make the cell waterproof, respectively. Saturated fat strengthens the immune system and protects against pathogens. DHA content was significantly higher in ghee prepared by the traditional method, this also has an effect on brain development.[69] *Swarna bhasma* which has *Madhura rasa* and *tridoshanasaka*, it is known for its *medhasmritiprada*, *Rasayan* property, is indicated for many diseases including *unmada.* cognitive functions are also impaired in *unmada*. Hence, it is evident that *swarna bhasma* has particular role in brain functions. In ancient times, the use of gold is mentioned to increase intellectual powers and longevity of life through the procedure of *Swarnaprashan*.[70] gold's medical value is employed it in the form of colloidal solution and nanoparticles.[71,72] It has many pharmacological actions, including anti-inflammatory and immunomodulatory.[73-75] Anti-asthmatic[76] increased brain functions,[40] antioxidant properties,[77-79] antibacterial activity,[80,81] antifungal activity,[82] anticancer,[83] and stimulates fertility.[83] And it also shows remarkable action on cognitive functions and memory improvement. Different studies have proven that *swarnabhasma* is able to prevent neuro inflammation and modulate mitochondrial function.[42] Gold nanoparticles has action on neurotransmitters they cause the inhibition of the breakdown of Acetylcholine which is considered the most important neurotransmitter involved in the regulation of cognitive functions. It imparts remarkable therapeutic effects on memory and learning.[85] Madhu is endowed with *Madhura*, *Kashaya rasa*, *tridoshasamaka* it is mentioned as a *yogavahi* drug in Ayurveda meaning, it has the property to increase bioavailability of other medicinal preparations. Along with this, it possesses many properties immunomodulatory[86] promote phagocytises, detoxification and proteolysis[87] Reducing frequency of cough[88] antibacterial Activity[89] wound-healing activity[86] Antioxidant Property Anti-inflammatory Effect, Mucolyticproperty.[90] There is direct reference regarding the action *madhu* on brain functions or cognition but its *yogavahi* nature help to increase bioavailability of other *medhya* drugs.

CONCLUSION

Cognitive function is a broad term that includes varied and complex brain activities such as attention, memory, processing speed, and executive functions which are reasoning, planning, problem solving, and multitasking. From the above data, it is evident that most of the ingredients in *bhrami Swarna yoga* have action on brain functions, including cognitive functions and memory enhancement. Hence, these drugs can be considered as good for cognitive and memory impairments.

REFERENCES

1. Itskovich E, Zyga O, Libove RA, Phillips JM, Garner JP, Parker KJ. Complex interplay between cognitive ability and social motivation in predicting social skill: A unique role for social motivation in children with autism. Autism Res 2021;14:86-92.
2. Carpenter M, Pennington BF, Rogers SJ. Understanding of others' intentions in children with autism. J Autism Dev Disord 2001;31:589-99.
3. Dinesh KS. Clinical Pediatrics in Ayurveda. Uttar Pradesh: Chowkhamba Sanskrit Sansthan; 2007.
4. National Research Council (U.S.). Committee on educational interventions for children with autism. In: Educating Children with Autism. Washington, DC: National Academy Press; 2001.
5. Yadav KD, Reddy KR, Kumar V. Encouraging effect of Brahmi Ghrita in amnesia. Int J Green Pharm 2013;7:122.
6. Singh HK, Dharwan BN. Neuropsychopharmacological effects of the Ayurvedic nootropic *Bacopa monniera* linn (Brahmi). Indian J Pharmacol 1997;29:S359-65.
7. Vollala VR, Upadhya S, Nayak S. Learning and memory-enhancing effect of *Bacopa monniera* in neonatal rats. Bratisl Lek Listy 2011;112:663-9.
8. Vollala VR, Upadhya S, Nayak S. Enhancement of basolateral amygdaloid neuronal dendritic arborization following *Bacopa monniera* extract treatment in adult rats. Clinics (Sao Paulo) 2011;66:663-71.
9. Ramasamy S, Chin SP, Sukumaran SD, Buckle MJ, Kiew LV, Chung LY. *In silico* and *in vitro* analysis of Bacoside A Aglycones and its derivatives as the constituents responsible for the cognitive effects of *Bacopa monnieri*. PLoS One 2015;10:e0126565.
10. Le XT, Pham HT, Do PT, Fujiwara H, Tanaka K, Li F, *et al*. *Bacopa monnieri* ameliorates memory deficits in olfactory bulbectomized mice: Possible involvement of glutamatergic and cholinergic systems. Neurochem Res 2013;38:2201-15.
11. Pham HT, Phan SV, Tran HN, Phi XT, Le XT, Nguyen KM, *et al*. *Bacopa monnieri* (L.) Ameliorates cognitive deficits caused in a trimethyltin-induced neurotoxicity model mice. Biol Pharm Bull 2019;42:1384-93.
12. Ong BA, Villanueva MC, Medina PM. *Bacopa monnieri* supplementation increases learning and short-term memory retention of sleep-deprived *Drosophila melanogaster*. J Appl Pharm Sci 2020;10:104-10.
13. Varshney M, Gari M, Bansal M. Effects of *Bacopa monnieri* and metformin on learning and memory in albino rats. IOSR J Dent Med Sci 2020;19:1-5.
14. Kamkaew N, Ingkaninan K, Waranuch N, Kaewmahanin W, Wasuntarawat C, Khongsombat O, *et al*. Efficacy of *Bacopa monnier*i on Memory and Vascular Functions: A Randomised Controlled Trial. https://doi.org/10.21203/rs.3.rs-2069630/v1
15. Rai R, Singh HK, Prasad S. A special extract of *Bacopa monnieri* (CDRI-08) restores learning and memory by upregulating expression of the NMDA receptor

subunit GluN2B in the brain of scopolamine-induced amnesic mice. Evid Based Complement Alternat Med 2015;2015:254303.
16. Anamika PK, Muralidharan P. Novel research on neuroprotective effect of *Bacopa monnieri* L. Against propionic acid induced investigation on autism in Sprague Dawley rats. Int J Health Sci 2022;6:10039-52.
17. Saini N, Singh D, Sandhir R. *Bacopa monnieri* prevents colchicine-induced dementia by anti-inflammatory action. Metab Brain Dis 2019;34:505-18.
18. Roodenrys S, Booth D, Bulzomi S, Phipps A, Micallef C, Smoker J. Chronic effects of Brahmi (*Bacopa monnieri*) on human memory. Neuropsychopharmacology 2002; 27:279-81.
19. Kwon HJ, Jung HY, Hahn KR, Kim W, Kim JW, Yoo DY, *et al*. *Bacopa monnieri* extract improves novel object recognition, cell proliferation, neuroblast differentiation, brain-derived neurotrophic factor, and phosphorylation of cAMP response element-binding protein in the dentate gyrus. Lab Anim Res 2018;34:239-47.
20. Ph DT, Hang PT. Study on the Effects of *Bacopa monnieri* (L.) Wettst extract, a traditional vietnamese herb and its potential compounds, bacoside a and-b, on cognitive and emotional deficits in an animal model of dementia, and molecular mechanism underlying their actions, Elsevier Science, 2020.
21. Rani A, Prasad S. A special extract of *Bacopa monnieri* (CDRI-08)-restored memory in CoCl2-hypoxia mimetic mice is associated with upregulation of fmr-1 gene expression in hippocampus. Evid Based Complement Alternat Med 2015;2015:347978.
22. Sudhakar A, Shantakumar J, Prasad CP, Joseph MV. Learning and memory enhancing effects of BacoLive® (an enriched composition of *Bacopa monnieri* extract) in scopolamine induced memory impaired mice. Am J Phytomed Clin Ther 2021;7:32.
23. Dethe S, Deepak M, Agarwal A. Elucidation of molecular mechanism(s) of cognition enhancing activity of bacomind(®): A standardized extract of *Bacopa monnieri*. Pharmacogn Mag 2016;12(Suppl 4):S482-7.
24. Peth-Nui T, Wattanathorn J, Muchimapura S, Tong-Un T, Piyavhatkul N, Rangseekajee P, *et al*. Effects of 12-week *Bacopa monnieri* consumption on attention, cognitive processing, working memory, and functions of both cholinergic and monoaminergic systems in healthy elderly volunteers. Evid Based Complement Alternat Med 2012;2012:606424.
25. Uabundit N, Wattanathorn J, Mucimapura S, Ingkaninan K. Cognitive enhancement and neuroprotective effects of *Bacopa monnieri* in Alzheimer's disease model. J Ethnopharmacol 2010;127:26-31.
26. Calabrese C, Gregory WL, Leo M, Kraemer D, Bone K, Oken B. Effects of a standardized *Bacopa monnieri* extract on cognitive performance, anxiety, and depression in the elderly: A randomized, double-blind, placebo-controlled trial. J Altern Complement Med 2008;14:707-13.
27. McPhee GM, Downey LA, Wesnes KA, Stough C. The neurocognitive effects of *Bacopa monneri* and cognitive training on markers of brain microstructure in healthy older adults. Front Aging Neurosci 2021;13:638109.
28. Bihaqi SW, Singh AP, Tiwari M. *In vivo* investigation of the neuroprotective property of *Convolvulus pluricaulis* in scopolamine-induced cognitive impairments in Wistar rats. Indian J Pharmacol 2011;43:520-5.
29. Amin H, Sharma R, Vyas H, Vyas M, Prajapati PK, Dwivedi R. Nootropic (medhya) effect of Bhāvita Śaṅkhapuṣpī tablets: A clinical appraisal. Anc Sci Life 2014;34:109-12.
30. Amin H, Sharma R. Nootropic efficacy of Satvavajaya Chikitsa and ayurvedic drug therapy: A comparative clinical exposition. Int J Yoga 2015;8:109-16.
31. Tiwari K, Joshi SC, Sharma OP. Exploring the effects of *Convolvulus pluricaulis* extract on memory in Albino rats. Indian J Health Wellbeing 2017;8:1058-60.
32. Malik J, Karan M, Vasisht K. Nootropic, anxiolytic and CNS-depressant studies on different plant sources of shankhpushpi. Pharm Biol 2011;49:1234-42.
33. Sharma K, Bhatnagar M, Kulkarni SK. Effect of *Convolvulus pluricaulis* choisy and *Asparagus racemosus* wild on learning and, memory in young and old mice: A comparative evaluation. Indian J Exp Biol 2010;48:479-85.
34. Sethiya NK, Nahata A, Singh PK, Mishra SH. Neuropharmacological evaluation on four traditional herbs used as nervine tonic and commonly available as Shankhpushpi in India. J Ayurveda Integr Med 2019;10:25-31.
35. Bihaqi SW, Sharma M, Singh AP, Tiwari M. Neuroprotective role of *Convolvulus pluricaulis* on aluminium induced neurotoxicity in rat brain. J Ethnopharmacol 2009;124:409-15.
36. Shukla D, Srivastava S, Jawaid T. Memory enhancing efficacy of an ayurvedic polyherbal formulation on scopolamine-induced memory deficit experimental models. Pharmacogn J 2020;12:589-97.
37. Yehuda S, Rabinovitz S, Mostofsky DI. Modulation of learning and neuronal membrane composition in the rat by essential fatty acid preparation: Time-course analysis. Neurochem Res 1998;23:627-34.
38. Dufoura F, Liua QY, Guseva P, Alkona D, Atzori M. Cholesterol-enriched diet affects spatial learning and synaptic function in hippocampal synapses. Brain Res 2006;1103:88-98.
39. Pandey A, Pawar MS. Assessment of nootropic activity of panchgavya ghrita in animal models. Int J Sci Res Publ 2015;5:1-5.
40. Abraham GE, McReynolds SA, Dill JS. Effect of colloidal metallic gold on cognitive functions-a pilot study. Front Perspect 1998;7:39-41.
41. Muller AP, Ferreira GK, Pires AJ, de Bem Silveira G, de Souza DL, Brandolfi JA, *et al*. Gold nanoparticles prevent cognitive deficits, oxidative stress and inflammation in a rat model of sporadic dementia of Alzheimer's type. Mater Sci Eng C Mater Biol Appl 2017;77:476-83.

42. Dos Santos Tramontin N, da Silva S, Arruda R, Ugioni KS, Canteiro PB, de Bem Silveira G, *et al*. Gold nanoparticles treatment reverses brain damage in Alzheimer's disease model. Mol Neurobiol 2020;57:926-36.
43. Shah ZA, Gilani RA, Sharma P, Vohora SB. Attenuation of stress-elicited brain catecholamines, serotonin and plasma corticosterone levels by calcined gold preparations used in Indian system of medicine. Basic Clin Pharmacol Toxicol 2005;96:469-74.
44. Bhaskaran JK, Nariya M, Patel KS, Rajagopala S, Aghera HB, Krishnaiah AB. Effect of Swarna bhasma on memory and learning in Swiss albino mice. J Res Tradit Med 2015;1:23-8.
45. Khan AY, Sheikh AA, Tenpe CR, Patole AM, Biyani KR. Neuroprotective efficacy of Swarna bhasma on sleep deprived induced cognitive impairments in rats. Indian Drugs 2018;55:43-8.
46. Choudhary S, Kumari I, Thakur S, Kaurav H, Chaudhary G. Brahmi (*Bacopa monnieri*)-a potential Ayurvedic cognitive enhancer and neuroprotective herb. Int J Ayurveda Pharm Res 2021;9:41-49.
47. Agrawal A. A Comparative Study of Psychotropic Drugs and Bio-Feedback Therapy in the Prevention and Management of Psychosomatic Disorder (Doctoral Dissertation, Thesis); 1993.
48. Vohora SB, Khanna T, Athar M, Ahmad B. Analgesic activity of bacosine, a new triterpene isolated from *Bacopa monnieri*. Fitoterapia (Milano) 1997;68:361-5.
49. Ceasar SA, Maxwell SL, Prasad KB, Karthigan M, Ignacimuthu S. Highly efficient shoot regeneration of *Bacopa monnieri* (L.) using a two-stage culture procedure and assessment of genetic integrity of micropropagated plants by RAPD. Acta Physiol Plant 2010;32:443-52.
50. Handa SS, Mundkinajeddu D, Mangal AK. Indian Herbal Pharmacopoeia. Vol. 1. Mumbai: A Joint Publication of Regional Research Laboratory Jammu and Indian Drug Manufacturers Association; 1998. p. 156-64.
51. Singh SK. Phytochemical analysis of leaf callus of *Bacopa monnieri* L. Int J Sci Res Publ 2012;2:1-3.
52. Sivaramakrishna C, Rao CV, Trimurtulu G, Vanisree M, Subbaraju GV. Triterpenoid glycosides from *Bacopa monnieri*. Phytochemistry 2005;66:2719-28.
53. Basu N. Chemical examination of *Bacopa monniera*, Wettst: Part III Bacoside B. Indian J Chem 1967;5:84-6.
54. Elangovan V, Govindasamy S, Ramamoorthy N, Balasubramanian K. *In vitro* studies on the anticancer activity of *Bacopa monnieri*. Fitoterapia (Milano) 1995;66:211-5.
55. Pandey G. Dravyaguna Vijnana. Part III. Varanasi: Chowkhamba Krishnadas Academy; 2004. p. 852.
56. Sharma PV. Dravyagun Vigyan. Varanasi: Chaukambha Bharti Academy; 2019.
57. Ranga V, Ranga S. General introduction of shankhpushpi according to ayurveda. World J Pharm Res 2021;10:2030-4.
58. Bhalero AS, Verma RD, Teli CN, Trikannad AA. Ethno-botany, phytochemistry and pharmacology of *Convolvulus pluricaulis*, Choisy. Res J Pharm Biol Chem Sci 2014;5:629-36.
59. Kidd BL, Photiou A, Inglis JJ. The role of inflammatory mediators on nociception and pain in arthritis. Novartis Found Symp 2004;260:122-33.
60. Agarwa P, Sharma B, Fatima A, Jain SK. An update on Ayurvedic herb *Convolvulus pluricaulis* Choisy. Asian Pac J Trop Biomed 2014;4:245-52.
61. Nahata A, Patil UK, Dixit VK. Anxiolytic activity of *Evolvulus alsinoides* and *Convulvulus pluricaulis* in rodents. Pharm Biol 2009;47:444-51.
62. Ravichandra VD, Ramesh C, Sridhar KA. Hepatoprotective potentials of aqueous extract of *Convolvulus pluricaulis* against thioacetamide induced liver damage in rats. Biomed Aging Pathol 2013;3:131-5.
63. Mishra SH, Sethiya NK. Review on ethnomedical uses and phytopharmacology of memory boosting herb *Convolvulus pluricaulis* choisy. Aust J Med Hebal 2010;22:19.
64. Rachitha P, Krupashree K, Jayashree GV, Kandikattu HK, Amruta N, Gopalan N, *et al*. Chemical composition, antioxidant potential, macromolecule damage and neuroprotective activity of *Convolvulus pluricaulis*. J Tradit Complement Med 2018;8:483-96.
65. Patil-Bhole T, Patil S, Wele AA. Assessment of bioavailability of gold Bhasma in human participants-a pilot study. J Ayurveda Integr Med 2018;9:294-7.
66. Kaushik R, Jain J, Rai P. Therapeutic potentials of cow derived products-a review. Int J Pharm Sci Res 2016;7:1383-90.
67. Available from: https://www.go-vigyan ausadhan Kendra.com [Last accessed on 2022 Dec 12].
68. Wastra P, Janness R. Dairy Chemistry and Physics. New York: John Wiley and Sons; 1984.
69. Goff HD, Hill AR. Chemistry and physics. Dairy Science Technology, Principles and Properties. New York: Wiley; 1993. p. 82.
70. Joshi KS. Docosahexaenoic acid content is significantly higher in ghrita prepared by traditional Ayurvedic method. J Ayurveda Integr Med 2014;5:85-8.
71. Acharya A. Charaka Samhita. Elaborated by Charaka and Drudhabala with Ayurveda Dipika Commentary by Chakrapanidatta, Edited by Yadavaji Trikamaji Acharya, Sutra Sthāna-46/132. Varanasi: Chaukhamba Surbharti Prakashana; 2008.
72. Bajaj S, Ahmad I, Raisuddin S, Vohora SB, Augmentation of nonspecific immunity in mice by gold preparations used in traditional systems of medicine. Indian J Med Res 2001;113:192-6.
73. Gaikwad AS. A Pharmaco-Clinical Study of the Effect of Madhu-Ghrita and Swarna-Vacha-Madhu-Ghrita on Neonates, MD Dissertation. Jamnagar: Gujarat Ayurved University; 2011.
74. Sravani K. A review on traditional Ayurvedic preparations containing gold. Int J Pharmacogn Phytochem Res 2017;9:801-7.
75. Klustermeyer WB, Noritake DT, Kwong FK.

Chrysotherapy in the treatment of corticosteroid dependent Asthma. J Allergy Clin Immunol 1987;79:720-5.
76. Brown CL, Bushell G, Whitehouse MW, Agrawal DS, Tupe SG, Paknikar KM, *et al*. Nanogoldpharmaceutics. Gold Bull 2007;40:245-50.
77. Dakhil MA, Buomy AA, Diab MS, Al-Quraishy S. Antioxidant and hepatoprotective role of gold nanoparticles against murine hepatic schistosomiasis. Int J Nanomedicine 2015;10:7467-75.
78. Bajaj S, Vohora SB. Analgesic activity of gold preparations used in Ayurveda and Unani-Tibb. Indian J Med Res 1998;108:104-11.
79. Senthilkumar S, Kashinath L, Ashok M, Rajendran A. Antibacterial properties and mechanism of gold nanoparticles obtained from *Pergularia daemia* leaf extract. J Nanomed Res 2017;6:00146.
80. Das S, Pandey A, Pal S, Kolya H, Tripathy T. Green synthesis, characterization and antibacterial activity of gold nanoparticles using hydroxyethyl starch-g-poly (methylacrylate-co-sodium acrylate): A novel biodegradable graft copolymer. J Mol Liq 2015;212:259-65.
81. Ahmad T, Wani IA, Lone IH, Ganguly A, Manzoor N, Ahmad A, *et al*. Antifungal activity of goldnanoparticles prepared by solvothermal method. Mater Res Bull 2013;48:12-20.
82. Huang X, Jain PK, El Sayeed EH, El Sayeed MA. Gold nanoparticles: Interesting optical properties and recent applications in cancer diagnostics and therapy. Nanomedicine (Lond) 2007;2:681-93.
83. Biswas NM, Chattopadhyay A, Sarkar M. Effects of gold on testicular steroidogenic and gametogenic functions in immature male albino rats. Life Sci 2004;76:629-36.
84. Bhaskara JK, Nariya M, Patel KS, Rajagopala S, Aghera HB, Krishnaiah AB. Effect of Swarna Bhasma on memory and learning in Swiss albino mice. J Res Tradit Med 2015;1:23-28.
85. Mandal MD, Mandal S. Honey: Its medicinal property and antibacterial activity. Asian Pac J Trop Biomed 2011;1:154-60.
86. Charde MS, Fulzele SV, Satturwar PM, Joshi SB, Kasture AV. Wound healing and anti-inflammatory potential of Madhu-Ghrita. Indian J Pharm Sci 2006;68:26-31.
87. Oduwole O, Udoh EE, Oyo-Ita A, Meremikwu MM. Honey for acute cough in children. Cochrane Database Syst Rev 2008;https://doi.org/10.1002/14651858.CD007094.
88. Al Somai N, Coley KE, Molan PC, Hancock BM. Susceptility of *Helicobacter pylori* to the antibacterial activity of Manuka honey. Russ Med J 1994;87:9-12.
89. Van den Berg AJ, van den Worm E, van Ufford HC, Halkes SB, Hoekstra MJ, Beukelman CJ. An *in vitro* examination of the antioxidant and anti-inflammatory properties of buckwheat honey. J Wound Care 2008;17:172-4, 176-8.
90. Tonks AJ, Cooper RA, Jones KP, Blair S, Parton J, Tonks A. Honey stimulates inflammatory cytokine production from monocytes. Cytokine 2003;21:242-7.

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